



Technical Support Document: Toxicology Clandestine Drug Labs: Methamphetamine

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LITHIUM

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Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

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OFFICE OF ENVIRONMENTAL
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I. Chemical Name

A. LITHIUM (Li)

B. Synonyms

Lithium metal, elemental lithium.

II. Role in Clandestine Drug Synthesis: Methamphetamine

Elemental lithium is used as a catalyst in the ammonia/alkali metal method (also referred to as the Nazi method) to synthesize methamphetamine from ephedrine.

III. Chemical Description

A. Appearance

Lithium is a soft, silvery-white metal that becomes yellowish upon exposure to moist air. It is soluble in liquid ammonia, producing a blue solution (HSDB, 2001).

B. Taste

Not available.

C. Odor

None (HSDB, 2001).

D. Odor Threshold

Not applicable.

E. Irritancy Threshold

Not applicable.

F. Odor Safety Class

Not applicable.

G. Vapor Density

Not applicable.

H. Vapor Pressure

Not applicable.

IV. Containers and Packaging

A. Commercial Products

Rechargeable camera batteries are frequently a source of elemental lithium. The lithium foil is removed from the batteries and stored in a non-polar solvent such as kerosene (Turkington, 2000). Lithium metal in the form of ribbon, wire, rod, ingot, granules, powder, or shot can be purchased from chemical supply houses.

B. Pharmaceutical Use

Lithium for pharmaceutical use (tablets, capsules, and liquid formulations) contains lithium carbonate or lithium citrate, both of which are salts of elemental lithium. Lithium salts cannot easily be used to make metallic lithium and are not used for illicit synthesis of methamphetamine.

V. Chemical Hazards

A. Reactivity

Compared with other alkali metals, lithium is less reactive than sodium and much less reactive than potassium. Unreacted metallic lithium is soft and silvery white. Freshly cut surfaces tarnish in air due to reaction with oxygen (forming lithium oxide, Li_2O) and nitrogen (forming lithium nitride, Li_3N). Pieces of lithium metal react slowly with water to liberate hydrogen, a flammable gas, but the reaction does not generate enough heat to cause spontaneous ignition (Cotton & Wilkinson, 1966). Finely divided and powdered lithium metal reacts vigorously with water to form flammable hydrogen gas and a strong caustic solution of lithium hydroxide (LiOH) (HSDB, 2001). Since reaction of finely divided lithium with water may lead to spontaneous ignition, powdered or granular lithium should not be combined with water (Kamienski et al., 1995). Finely divided lithium metal may also ignite in air at ambient temperature. If heated to its melting point (357 °F or 181 °C), lithium is likely to ignite spontaneously (HSDB, 2001).

B. Flammability

Lithium is classified as a flammable solid (HSDB, 2001).

C. Chemical Incompatibilities

Powdered lithium may react explosively with water. Lithium reacts vigorously and may ignite on contact with nitric acid. Lithium reacts with halogenated hydrocarbons such as bromine, bromoform, chloroform, methylene chloride, chlorofluorocarbon solvents (e.g., Freon 11 and Freon 113), trichloroethylene, perchloroethylene, sodium nitrite, and elemental sulfur (HSDB, 2001).

VI. Health Hazards

A. General

Dermal contact and inhalation are not likely to be significant routes of exposure to this material. In general, metals are poorly absorbed across the skin, so it is likely that contact with metallic lithium will not result in appreciable systemic absorption. Ingestion of small pieces of lithium foil, particularly by children, appears to be the most likely route of exposure. Little information on the toxicity of elemental lithium is available. However, lithium carbonate and lithium citrate (lithium salts) are used in medicine to treat manic-depressive illness (bipolar disorder), and information on the toxicity of ingested lithium salts is available (Hardman et al., 1996). Most of the toxicity information summarized in this document was obtained from experience with the medical use of lithium carbonate and citrate. Ingested in excessive amounts, lithium primarily affects the gastrointestinal (GI) tract, the central nervous system, and the kidneys. Acute GI effects include abdominal pain, nausea, vomiting, and diarrhea. Nervous system effects include tremors, loss of muscle coordination, muscle rigidity, and exaggerated reflexes. Sedation, mental confusion, agitation, seizures, and coma may occur at high doses. Symptoms associated with kidney toxicity include an initial increase in urine output (polyuria), subsequent elevation in blood non-protein nitrogen, and finally, diminished urine output (oliguria) (HSDB, 2001; Meditext, 2003; Stokinger, 1981).

B. Acute Effects

Mild cases of acute toxicity following ingestion of lithium are characterized by nausea, abdominal pain, vomiting, diarrhea, sedation, and mild tremors. In more serious cases, symptoms include severe tremors, loss of muscular coordination (ataxia), agitation, mental confusion, convulsions, and coma. Neurological symptoms following mild to moderate acute exposure include agitation, tremor, exaggerated reflexes (hyperreflexia), lack of muscular coordination (ataxia), slurred speech, lethargy, and confusion (HSDB, 2001). Occasionally, neurological damage may be irreversible. Other potential adverse effects include cardiac arrhythmias, low blood pressure (hypotension), and excretion of protein in the urine (albuminuria) (Meditext, 2003, Hardman et al., 1996). Adult respiratory distress syndrome (ARDS) has been reported in cases of severe intoxication. Manifestations of ARDS include shortness of breath, rapid breathing, and low arterial blood oxygen (Meditext, 2003).

C. Chronic Effects

Chronic lithium therapy may result in kidney toxicity (Hardman et al., 1996). Diminished urine output in relation to fluid intake (oliguria) has been reported following chronic exposure (HSDB, 2001). In lab animals dosed chronically, the primary toxic action of lithium is on kidney function. Lithium excretion may lag behind intake, and lithium accumulation (increased body burden) may occur. Kidney toxicity is manifested by a transition from initially profuse urine output (polyuria) to reduced urine output (oliguria), accompanied by a rise in blood lithium levels (Stokinger, 1981). Chronic lithium intoxication may lead to temporary blurred vision and blindness; unusual sensitivity to light (photophobia) has also been reported. Reduced heart rate (bradycardia) and significant drop in blood pressure (hypotension) may develop as a result of severe, usually chronic exposure to lithium. Chronic exposure to lithium may be aggravated by dehydration, concurrent illness, or interactions with other drugs. In such cases, symptoms of neurological toxicity may develop after exposure to relatively small amounts of lithium. Dehydration is a common finding in persons with chronic lithium toxicity (HSDB, 2001).

D. Skin Contact

Dermal uptake of lithium is not likely to be a significant route of exposure. The physical forms of lithium that are commonly used for methamphetamine synthesis (ribbon, wire, rod, foil, etc.) do not present a health hazard when touched or handled. As is the case with virtually all metals, absorption across the skin is likely to be poor. Contact with finely divided lithium or lithium powder would present a hazard because these forms may react with skin moisture to form hydrogen gas and lithium hydroxide, which are flammable and corrosive, respectively.

E. Eye Contact

Eye contact with lithium particles may result in serious injury due to formation of lithium hydroxide (LiOH), a strong base that is highly corrosive.

F. Inhalation

Inhalation of finely divided lithium particles may result in serious injury to the nasal passages, upper airways, and lungs due to formation of lithium hydroxide (LiOH), a strong base that is highly corrosive.

G. Ingestion

Ingested lithium primarily affects the gastrointestinal (GI) tract, the central nervous system, and the kidneys. Adverse effects on the GI tract frequently include abdominal pain, nausea, vomiting,

and diarrhea. Nervous system effects include fine tremor of hands; occasionally, tremor of the lips and jaws may be apparent. Other signs include loss of muscle coordination, muscle rigidity, and exaggerated reflexes. Sedation, mental confusion, agitation, seizures, and coma may occur at high doses. Symptoms associated with kidney toxicity are an initial increase in urine output (polyuria), subsequent elevation in blood non-protein nitrogen, and finally, diminished urine output (oliguria) (HSDB, 2001; Meditext, 2003; Stokinger, 1981).

H. Predisposing Conditions

The toxicity of lithium is determined not only by the amount of lithium ingested, but also by the amount of sodium in the diet; reduced sodium intake enhances the toxicity of lithium (Stokinger, 1981).

I. Special Concerns for Children

Experimental studies evaluating the potential of lithium chloride to produce birth defects in laboratory animals have produced contradictory results (Stokinger, 1981).

VII. First Aid

A. Eyes

Flush eyes with water for at least thirty minutes. Do not rub eyes or keep eyes closed. Get medical attention immediately (Fisher, 2000).

B. Skin

Remove contaminated clothing. Flush skin with plenty of soap and water for at least fifteen minutes. Seek medical attention immediately (Fisher, 2000).

C. Ingestion

If victim is conscious, give 2-4 cups of milk or water. Do not induce vomiting. Seek medical attention immediately (Fisher, 2000).

D. Inhalation

Remove victim to fresh air immediately. If breathing is difficult, administer oxygen; however, if individual is not breathing, give artificial respiration, but do not give mouth-to-mouth resuscitation (use oxygen and a suitable mechanical device). Seek medical attention immediately (Fisher, 2000).

VIII. Standards for Inhalation Exposure

NOTE: Occupational and emergency response exposure guidelines for *lithium hydride*, a specific lithium compound, are available. Lithium hydride is a flammable, moisture sensitive solid, and is not used by clandestine drug lab operators to synthesize methamphetamine. Exposure standards for lithium hydride are not applicable to elemental lithium.

A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

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|--|------------------|
| 1. Ceiling Limit (C) (not to be exceeded at any time): | Not established. |
| 2. Short-Term Exposure Limit (STEL or ST): | Not established. |
| 3. 8-Hour Time Weighted Average (TWA): | Not established. |
| 4. 10-Hour Time Weighted Average (TWA): | Not established. |
| 5. Immediately Dangerous to Life & Health (IDLH): | Not established. |

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

“Skin” notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

- | | |
|--|------------------|
| 1. ERPG-1 (protective against mild, transient effects): | Not established. |
| 2. ERPG-2 (protective against serious adverse effects): | Not established. |
| 3. ERPG-3 (protective against life-threatening effects): | Not established. |

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention strategies and response capabilities. ERPGs assume that the duration of exposure is one hour

or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

C. Acute Reference Exposure Level (1-hour exposure) (OEHHA, 1999)

Level protective against mild adverse effects:

Not established.

D. Chronic Reference Exposure Level (multiple years) (OEHHA, 2002)

Level protective of adverse health effects:

Not established.

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

E. Chronic Reference Concentration (lifetime exposure) (IRIS, 2003)

Level protective of adverse health effects:

Not established.

IX. Environmental Contamination Concerns

NOTE: Only small amounts of lithium are required for synthesis of methamphetamine. A common source of lithium is the foil in rechargeable camera batteries (Turkington, 2000). For this reason, waste generated by a clandestine methamphetamine lab is unlikely to result in significant lithium contamination of soil, surface water, or groundwater.

A. Surface Water

No information available.

B. Groundwater

No information available.

C. Drinking Water

California state standards for lithium compounds in drinking water have not been established (RWQCB, 2000).

Suggested No Adverse Response Level (NAS, 1980): Not established.

Preliminary Remediation Goal for Tap Water (U.S. EPA, 2002 Region IX): 730 ppb (730 µg/l)

D. Soil

NOTE: The "background" lithium content of the earth's crust is estimated to be from 20 to 70 ppm by weight. However, the concentration of lithium in soil varies significantly depending on geographic location and soil type (Kamienski et al., 1995). As noted above, significant environmental contamination resulting from the use of lithium as a catalyst for methamphetamine synthesis is unlikely because very small quantities of the metal are needed for this purpose.

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX):
1,600 ppm (1,600 mg/kg)

E. Air

No information available.

Preliminary Remediation Goal for Ambient Air (U.S. EPA, 2002 Region IX): Not established.

F. Indoor Surface Contamination

Metallic lithium will react with nitrogen, oxygen, and water vapor in air (Cotton & Wilkinson, 1966). Consequently, the lithium surface becomes coated with a mixture of lithium hydroxide (LiOH), lithium carbonate (Li₂CO₃), and lithium nitride (Li₃N) (Kamienski et al., 1995). Lithium hydroxide represents a potentially significant hazard because it is extremely corrosive. Physically, lithium used for synthesis of methamphetamine is often in the form of small pieces of foil. In most cases, the amount of LiOH that forms on the surface of these pieces will be small.

X. Personal Protective Equipment

Wear chemical safety goggles and protective clothing (Fisher, 2000). To prevent contact with this material, corrosion-resistant gloves should be worn. Respiratory protection is required if lithium is present as a finely divided powder, but this form of the metal is not associated with clandestine methamphetamine synthesis.

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